The Northwestern MILLER
MILLING PRODUCTION SECTION

How the U.S.S.R. Adopted U.S. Milling Techniques

By N. I. Pesakhowich
Milling Engineer, Tel Aviv, Israel

EDITOR'S NOTE: In the course of a recent assignment to Israel under the auspices of the United Nations Food and Agriculture Organization, Dr. Max Milner of the Department of Flour and Feed Milling Industries, Kansas State College, became acquainted with numerous individuals engaged in the milling and grain industries in that country. Many of these people had received their education and professional experience in other countries before coming to Israel. One of these is a milling engineer, N. I. Pesakhowich, who had studied and practiced in Soviet Russia for many years. He told Dr. Milner about his personal involvement in the changeover of the Russian milling industry to U.S. methods which occurred in the late 1920's. Dr. Milner became so interested in this facet of modern technical history which is virtually unknown in the western countries, that he offered to assist Mr. Pesakhowich in bringing these facts to the attention of readers in the U.S. The present account was prepared by Mr. Pesakhowich and Dr. Milner with the assistance of Mrs. Nadia Lourie who prepared the first translation from the original Russian.

The technical information presented is necessarily brief, although most of it may be found in greater detail in one or more of the Russian literature citations at the end of the article. Unfortunately, little of this material has been translated into English.

In 1924 a group of milling specialists under the leadership of the late Prof. P. A. Kozmin, decided to investigate the introduction into the USSR of American operating speeds in roller mills. They undertook this project in the face of disapproval and even active opposition from the engineers who were then conducting the flour industries in that country. In spite of this obstacle they succeeded in starting experiments that year in the state-owned flour mill No. 72 at Dniepropetrovsk. These experiments, conducted on only one second break roller mill proved immediately that the capacity was roughly proportional to the velocity of the corrugated rolls and that the quality of the product was not affected by the increased speed. These facts were submitted in a report to the Congress of Ukrainian Engineers and Technicians in May, 1924. Specialists at this congress received this report without enthusiasm. They claimed that the American speeds in corrugated rolls are adapted only to the peculiar quality of American wheat and would not be suitable with Russian wheats.

In spite of this unfavorable reaction the group which favored investigation of American techniques introduced in the same year, 1924, at Mill No. 18 in the town of Genitchesk, American speeds on the break system while retaining the original flow sheet in the rest of the mill. This meant a peripheral roll velocity of 3½ meters per second on the reduction system and higher speeds of 7 meters per second for the break stages. These velocities compare with 9 in. roll speeds of 150 and 300 r.p.m., respectively, in U.S. equivalents.

This mill immediately began to process 140-150 tons of wheat in 24 hours instead of 100-110 tons as previously, achieving at the same time improved quality in the three types of flour produced. These reports failed to convince the directorate of the Millstroy (mill building agency) and of "Ukrchleb" (trust for the operation of mills in the Ukraine) of the feasibility of introducing the American speeds in the break system in all the mills. The Directorate of the Millstroy pointed out that this innovation of higher speeds on break rolls had been carried out with new roller mills of very solid construction (type DD manufactured by Buhler Bros. of Switzerland) and that even these roller mills would probably not withstand such intensive operation for long. This would suggest that the introduction of American speeds into the older roller mills, still operating in many flour mills in the country, would be even more questionable and impractical.

Nevertheless, in 1926 an American five-break system with a roll speed of 4.75 meters per second was intro-

(Continued on page 17a)

Table 1—Projected and Actual Peripheral Roll Speeds, Loads and Production Obtained During Trials at Mill No. 78 at Zaporojdye

Milling trial No.	Roll Speed Meters per second Load: 164.4 Kg./25mm Projected	Actual	Production Kg./hr. Projected	Actual	Comments
1	7.0	7.2	195	200	Local grain
2	6.0	6.0	165	167	Local grain
3	5.0	5.5	140	153	Local grain
4	4.0	4.4	110	122	Local grain
5	7.0	6.6	196	183	System of Edgar Miller
6	6.0	6.5	165	181	Siberian grain
7	6.0	6.1	165	171	System of Edgar Miller
8	6.0	6.6	165	183	System of Edgar Miller
9	6.0	6.3	165	175	Local grain
10	..	4.0	...	111	Restored European speed

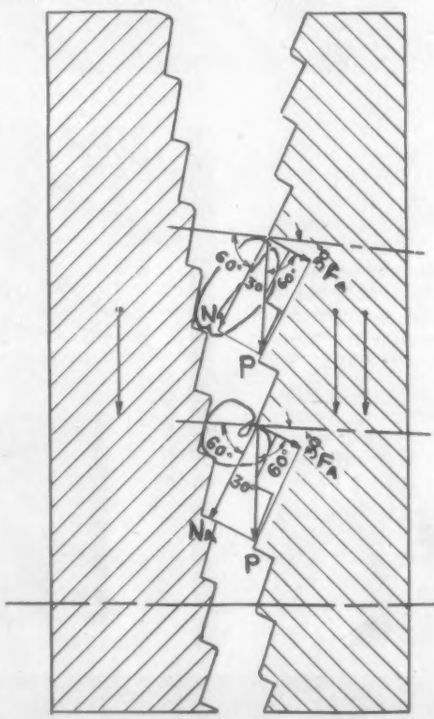

Fig. 1
German Grooving
(Fluting)

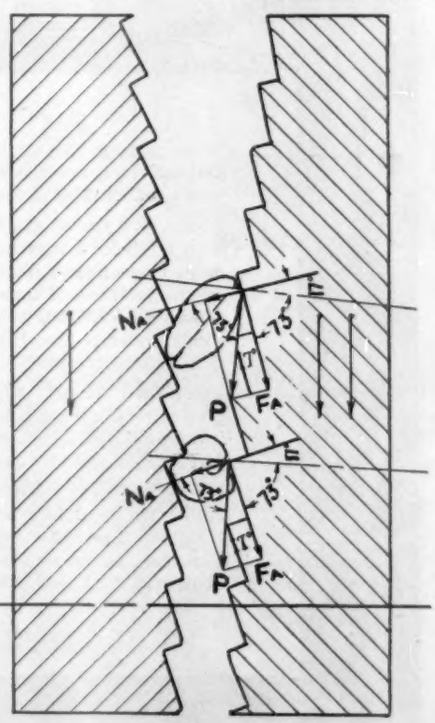

Fig. 2
American Grooving
(Fluting)

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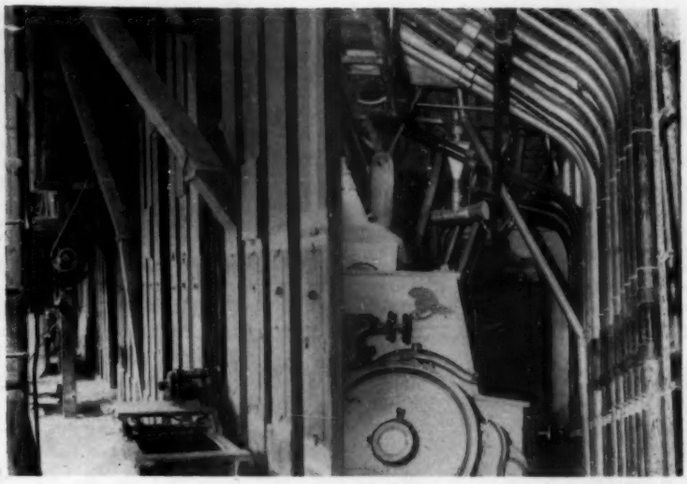


THE ROLLER FLOOR—A before and after picture. On the left is shown the roller floor as it was with its cumbersome timber spouting. In the remodeled mill, as shown at right, slim pneumatic tubes have replaced the old system.

Modernization Project Brings Reduced Production Costs and Bigger Capacity

An increase in capacity of more than 35%, greater efficiency of production, and a corresponding reduction in operating costs, have been achieved by the Ellison Mill and Elevator Co., Ltd., at its Lethbridge, Alta., plant as a result of a major modernization program.

The Canadian company awarded the contract for the work of reconstruction to Thomas Robinson & Sons, Ltd., milling engineers, Rochdale, England, through Kipp Kelly, Ltd., the firm's agent in Canada.

Read C. Ellison, manager of the milling company, reporting his satisfaction with the work, says that the new mill was making saleable flour within a few hours of start-up and full feed was attained within 36 hours running time. Capacity has been increased from 1,100 bbl. to 1,500 bbl., basis 24 hours working.

In addition to the two patented conveying systems, "Pneu-Flow" and "Pneu-Spout", Robinsons introduced their all-metal purifier, type PHm, and the "Pneu-Roll", type MEm, into the mill. The rollermill first appeared on the market in 1952, and the purifier was shown for the first time in North America at the annual technical conference of the Association of Operative Millers in St. Louis last May. The whole of the equipment used in the remodeling project has been conceived in the past four years. an indication of the complete modernization of the plant.

The Ellison company draws its wheat from southern Alberta, reputedly one of Canada's better wheat growing areas. Bulk wagons delivering grain tip into a hopper feeding the elevator which deposits the grain into 55 concrete silo bins, with a total capacity of 404 500 bu. From the silo the wheat enters the wheat-cleaning department to be treated by an Aspirator, Millerator and three disc separators, being finally cleaned, damped, and stoned, by a Robinson Washer, Whizzer and Stoner.

The grinding section has been almost doubled, with a total availability of 31 rollermills. Two of these, however, are employed in the whole wheat plant. In the flour mill proper the diagram has been arranged in accordance with the most modern practice to give the best possible milling results under a wide variety of conditions. The sifting section comprises nine four-section sifters and three high speed sifters. These machines have been repositioned to improve the angle of fall of deliveries.

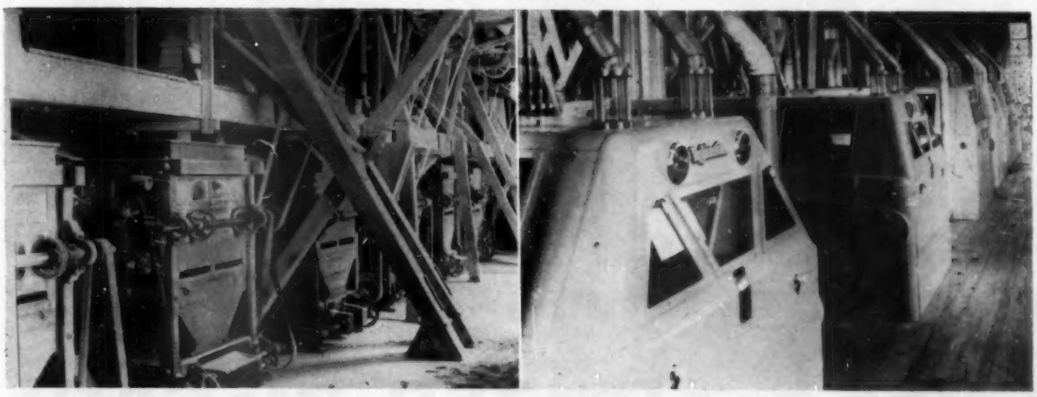
It is in the purification section that the most significant changes have been made. Nine machines, arranged in a double row, give 13 purification passages. These all-metal machines have individual motor drives and are exhausted through new high speed tubular trunking. Also accommodated on the purifier floor are bran dusters, a shorts duster, and flour weighers and conveyors.

On the top floor, mounted at the head of each pneumatic lift, are the receiving cyclones and wheel valves. These are all exhausted into new Robinson filter sleeve-type dust collectors. In order to cutback heating expenses in winter, 14,000 cu. ft. of clean exhaust air leaving the dust collectors every minute is directed back into the mill.

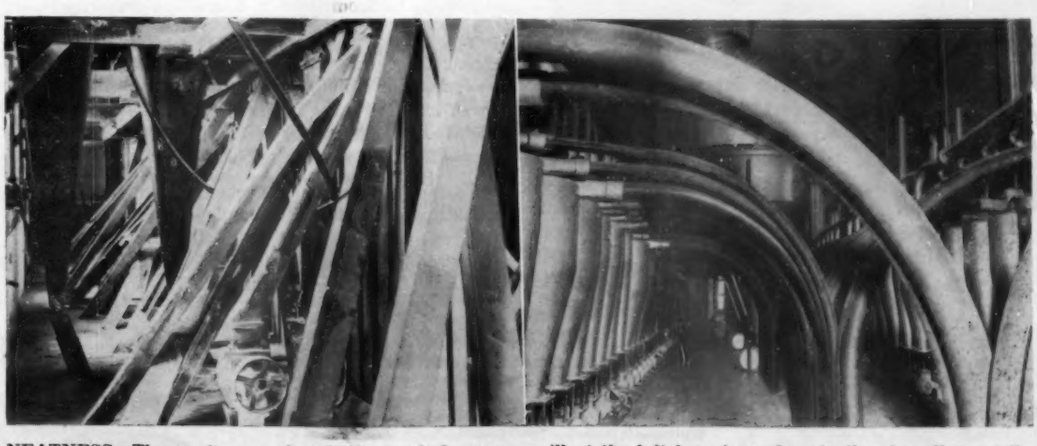
After rebolting and weighing the finished products arrive on the top floor through seven pneumatic lifts. These discharge into a double Gardiner band conveyor which directs the flour into 16 bulk storage bins, each with a capacity of 25 tons. These bins, recently completed under the expansion program, hold 72 hours mill run. Hand trucking is no longer required because conveying belts carry flour from the bagging room to the warehouse. Automatic bag packers and stitchers operate in the new storage building alongside the railroad facilities.

The Ellison Milling and Elevator Co., founded by Ephraim Ellison, celebrates its golden anniversary in 1956.

(Continued on page 14a)



PURIFIERS—A before and after picture of the purifier floor. The picture at left shows the floor as it was before the remodeling program. The old machines have been replaced by the latest all-metal Robinson purifiers and the picture on the right is indicative of the more efficient working facilities.



NEATNESS—The neatness and orderliness of the new mill is pointed up by these "before and after" pictures of the top floor. The maze of wooden spouting in the old mill at the left has given place to the clean lines of the new. The pneumatic lifts sweep into the cyclone collectors which have replaced the elevators.

A New Moisture Tester

By T. A. Oxley

EDITOR'S NOTE: In the following article, T. A. Oxley tells of the development in England of a new instantaneous moisture tester. Mr. Oxley, the inventor, is head of the grain storage section of the Department of Scientific and Industrial Research in England. The tester, developed primarily for grain in sacks, also can be used for grain in bulk, Mr. Oxley said. Moisture content is read instantaneously, expressed in per cent. Temperature variations are taken into account by a dial setting which gives a corrected reading. The production prototype is being first demonstrated this month. This article is reprinted from the English publication "The Agricultural Merchant."

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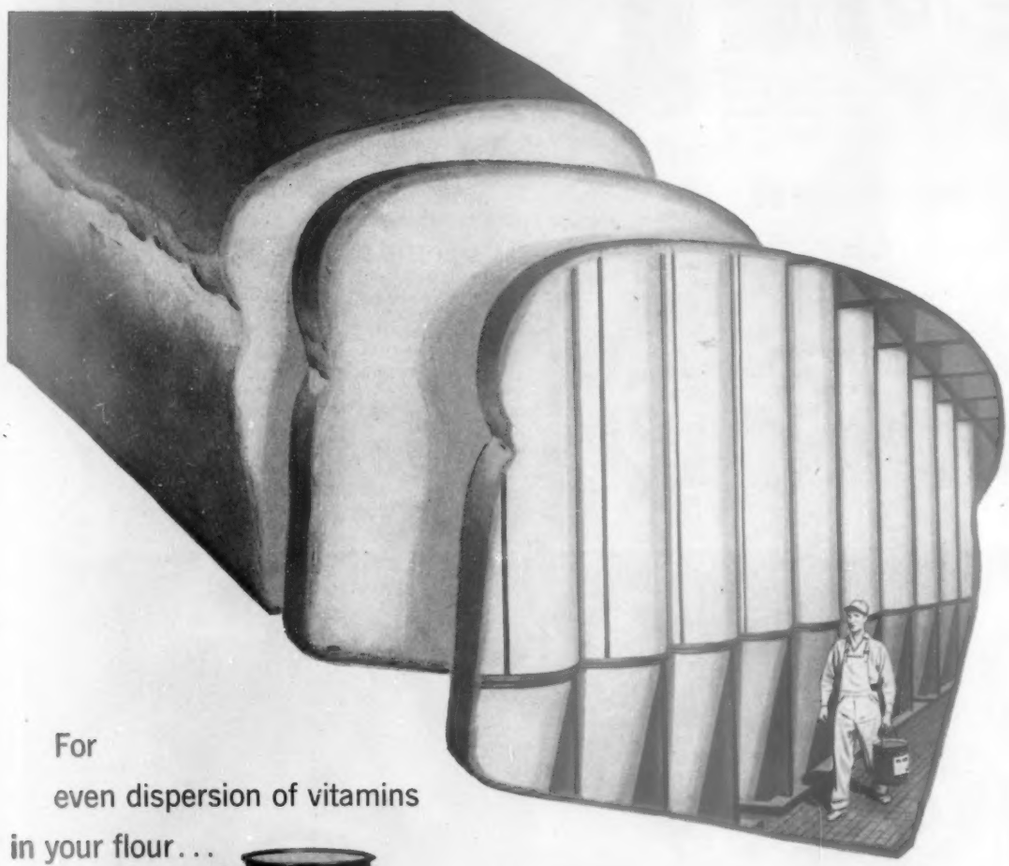
It is generally agreed that moisture content is one of the most important characteristics of grain and seeds. The level of moisture content not only determines the keeping quality of the grain, but also the amount of water which is bought and sold at the price of grain. The latter is a most fertile source of gain or loss for the miller or compounder, whose finished product cannot contain more than a certain amount of water, irrespective of how much there may have been in his raw material.

Moisture content should be considered at every purchase or sale of grain, especially if there is reason to suspect unevenness in the parcel. Every merchant, of course, makes his



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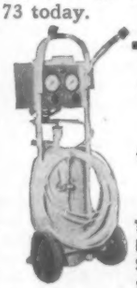

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own judgment based on feel, bite, smell and appearance, but when hard cash is involved, and when the possible need for costly drying hangs in the balance, these judgments can be very badly out indeed. Over the years a man becomes very skilful at estimating moisture content by feel and bite. Yet even the skilled man, in spite of his years of experience, can be quite seriously in error. If one wants to be more accurate, to be consistent when switching quickly from one kind of grain to another, to eliminate the personal factor, and to do as well with an unskilled man as a skilled, a moisture meter is essential.

Moisture meters, hitherto, have suffered from two defects which have made them quite unsuitable for use at the moment of purchasing or taking delivery of grain:—(a) they are too slow, and (b) a sample must be taken from the bulk. The Pest Infestation Laboratory of the Department of Scientific and Industrial Research has been faced with this problem many times, especially in its overseas work. The laboratory therefore decided to attempt to develop a meter which would give a direct reading, instantaneously or nearly so, when a probe or spear was stuck into the grain. It was considered essential that the spear should be narrow enough to be capable of being driven through a sack without using too much force or greatly damaging the sack.

The requirement of an instantaneous reading seemed to demand an electrical method, yet it was agreed that batteries or main connections should be avoided if possible. The problem was made simpler by the decision that some degree of accu-

(Continued on page 13a)

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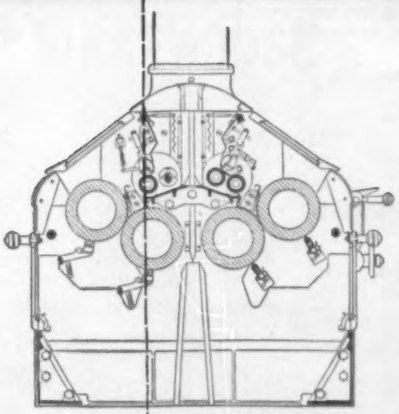

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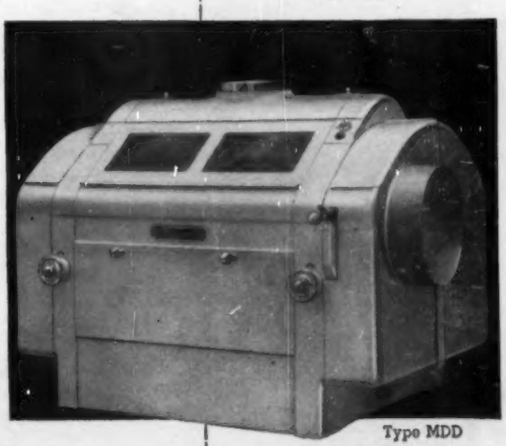

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477

The Functions and Characteristics Of Purifiers

By Eric A. Stanger

EDITOR'S NOTE: Mr. Stanger is general manager in North America for Henry Simon, Ltd., milling engineers, Cheadle Heath, England. His article is taken from a talk he gave to the Association of Operative Millers at the 1955 technical conference in St. Louis. After dealing with the essential functions of the purifier he gives an account of investigations into the characteristics of the various forms of purifier and then describes a new model recently developed. This machine incorporates suggestions made by the AOM technical committee.

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The purifier has two main purposes. It is required to separate clean granular stock from the mixed branny particles and to divide the clean stock into accurately graded fractions for feeding to the succeeding reduction rolls. Some purification in this sense can be achieved with a simple oscillating sieve fitted with graded covers. This is because in the feed to a purifier the finer stock contains less bran than the coarse stock. The throughs of the head sheets therefore tend to be clean; the branny stocks are concentrated towards the tail of the machine.

Sieving action alone separates material mostly by size. It makes little use of the characteristically flatter shape of the branny particles. The purifier as we know it today separates by shape as well as by size. Its efficiency comes from two causes: the gentle agitation of the oscillating motion and the lifting action of the air moving upwards. These jointly "fluidize" the layer of stock. The fluidizing improves the grading action by allowing the fine granular particles to work freely down through the stock to concentrate just above the sieve cover. In addition, the upward movement of the air lifts the flatter branny particles more easily than particles of endosperm and keeps the former away from the sieve cover so that fewer branny particles are found in the throughs.

A good purifier is one which separates and grades the clean stock as well as possible, is simple to operate and is economical in air and space, has a high capacity and consumes a minimum of power.

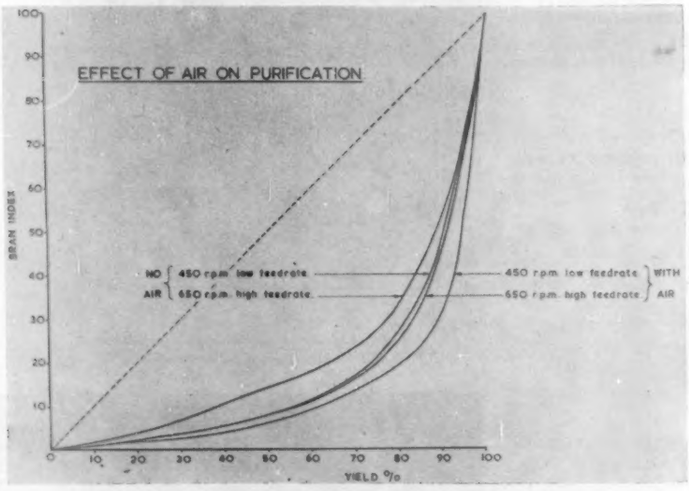

Figure 1

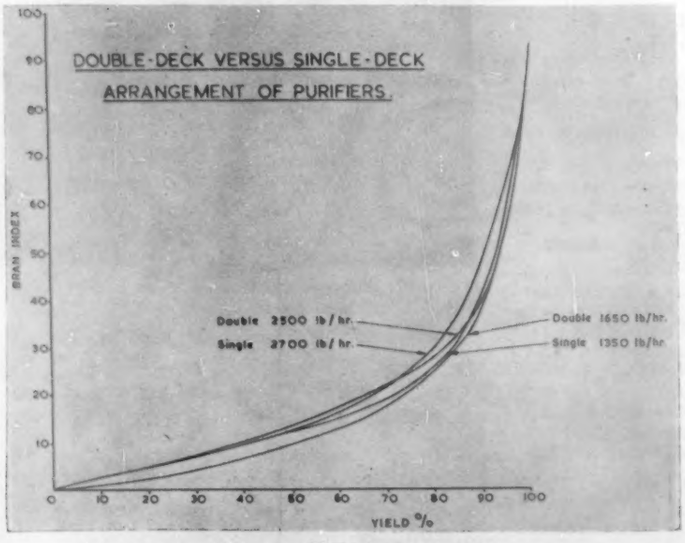

Figure 2

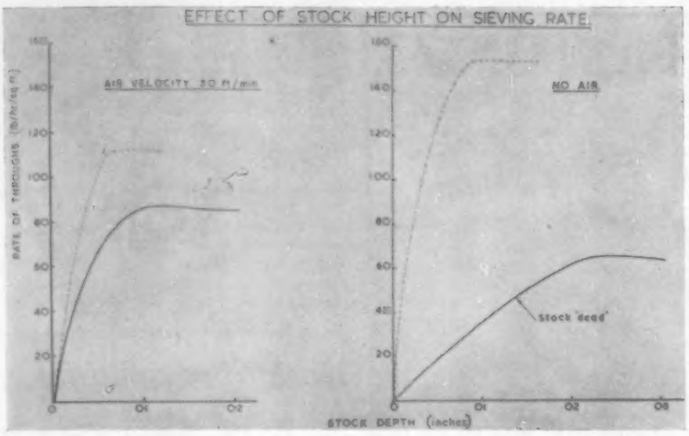

Figure 3

In recent years we have been able to carry out in our research laboratories a number of experiments which show the nature of the separations which can be made by typical forms of purifier arrangement and these experiments show just how important the various characteristic features are which go to make up an efficient purifier. To carry out this investigation we built a special laboratory purifier. This machine is large enough in principal dimensions to represent a mill purifier but is built so that the sieve construction and motion, the air distribution and the feed rate can be carefully controlled yet quickly altered for purposes of comparison. The inclination of the sieve supporting hangers, the speed and the stroke of the sieve are variable over a wide range. The sieve itself can be a single series of graded covers or a double deck of covers mounted in a common frame. The width of the sieve is, however, reduced to six inches so that sieve cover can be kept taut without special precautions and so that tests can be made with the minimum of stock. The exhaust hood over the sieve is subdivided by cross walls into a number of small sections, each connected to a separate air pipe through which air can be drawn in controlled and measured quantities. By this means the distribution of the air along the sieve can be made to conform to any required pattern. The machine was arranged so that "tins" could be readily fitted to, or removed from the space just above the sieve. Complete rearrangement of the motion, the sieve construction or the air distribution could be made in a matter of a few minutes.

Methods of Assessment

We have been able to carry out many experiments with the machine. Stock was fed at selected feed rates and the various separated fractions were measured and assessed for quality.

The separated products of the various tests were assessed by the traditional visual methods of comparing stock quality. In addition, we set up two further methods for assessing the nature of the separations. The first is a simple physical method for determining stock size and quality and consists of a type of micro-projector arranged for direct vision so that the size distribution, the color and texture of separated fractions could be judged quickly. Even minor contamination with bran or germ fragments shows up very clearly, or conversely pieces of good semolina in the tails become very obvious. This test therefore provides a clearer picture of the work of a purifier than normal visual examination of the samples, yet it takes practically no longer to carry out.

Bran Index

The second is a form of photo-electric grader which we have developed specially for comparisons of stock quality in terms of color. This gives an index of stock quality which we have called the "bran index" providing a figure which we are able to carry over from one test to another.

This photo-electric color discriminator requires a few words of explanation. In making comparisons of purifier efficiency, the chief interest lies in the destination of the bran particles. It is customary to estimate the extent of bran contamination of a mill stock in terms of ash content, but in certain circumstances this can lead to false conclusions. Fine bran, such, for example, as is lifted to purifier "tins" may consist mostly of outer layers of the seed coating and contain little of the inner layers (e.g., aleurone layer) which are high in ash content; if such bran fragments find their way through the head sheets, ash figures will not show the presence of bran as effectively as if aleurone particles were present. We have looked, therefore, for some index more closely related to fiber content than to ash content, as the fiber content of both outer and inner layers of the bran is relatively high, and there is little difference between

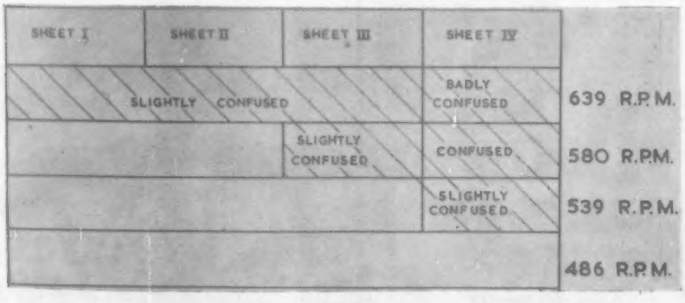

Figure 4

them. Fiber determinations themselves are so lengthy and cumbersome as to be impracticable in the long range of testing that we envisaged and we therefore concentrated on finding some more rapid and convenient method which would serve instead. The method chosen was to determine the reflectivity in the green region of the spectrum for dry stock compacted in a standard fashion in a glass cell. The possibility of this method was suggested by the published work of Kent-Jones and Amos on the one hand and of J. A. Anderson on the other on color grading of flour.

Modified Kent-Jones Instrument

The equipment used consists of a modified form of the Kent-Jones color grader. The instrument was reduced in sensitivity so that a wider range of reflecting power could be measured. The indicating dial of the machine was renumbered according to a scale of increasing depth of stock color. It was found by careful test that the readings or "grade figures" for a long range of mill stocks correlate closely with fiber content and, further, that with the right choice of scaling of the dial the grade figures can be made proportionate to fiber concentration. We can, therefore, use the grade figures to measure the bran contamination (like fiber content) of the stock. We have found it convenient to construct from our readings a "bran index" which may be regarded as the proportion of the total bran contamination of the feed which is to be found in a particular separation fraction. This is calculated from the grade figure by multiplying by the percentage weight which the sample forms of the feed to the machine and dividing by the grade figure of the feed. Thus for example if the feed to a machine has a Grade Figure of 50, and a separated fraction which forms 20% of the whole has a Grade Figure of 10, then the "bran index" is given by the formula: $10 \times 20 \div 50$. The "bran index" method of assessing stock quality has two advantages. Firstly, the high correlation between bran index and fiber content shows that bran index can be regarded as an index of impurity almost equally well as can fiber content. Secondly, a test of impurity by this means takes only a minute or so and many hundreds of tests can be carried out without undue labor, and the figures recorded for future comparison.

With this special laboratory purifier comparative tests have been made, for example, to find the effects of single against double deck arrangements of sieve, of the fitting of "tins" above the sieve, of high against low air quantity and of high against low feed rates. We have been able to study the effect of sieve speed, sieve stroke, stock depth, and level of air flow on the quality and the rate of throughs of the covers. We have also been able to study the effect of the

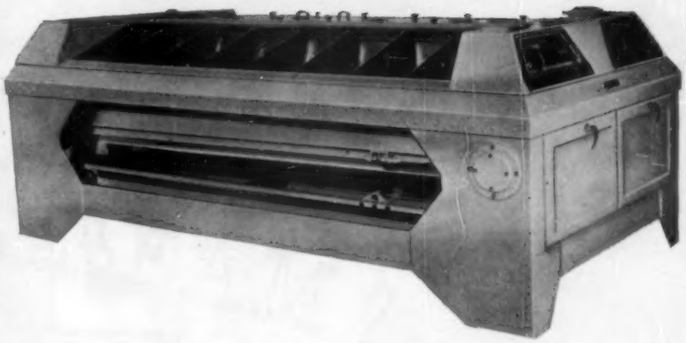

Figure 6—Type S. Purifier

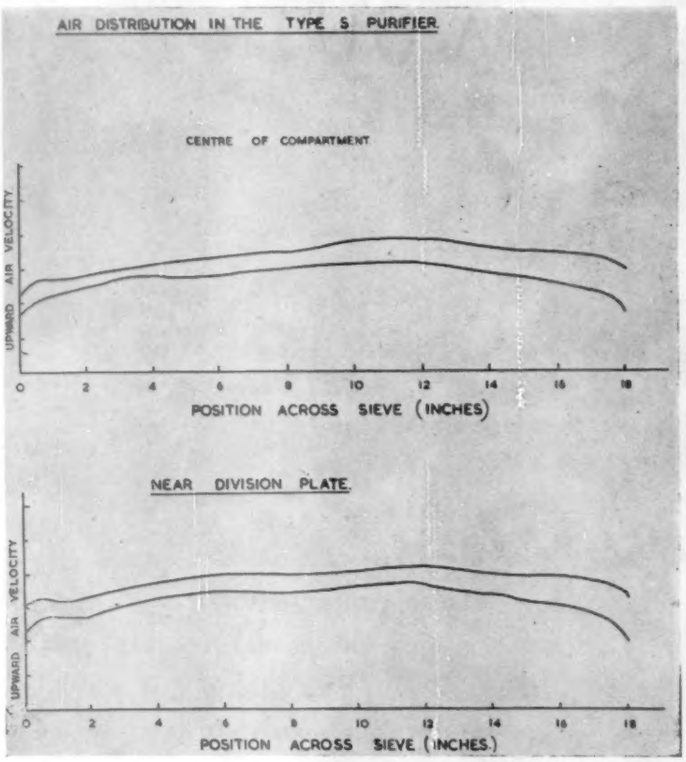
AIR DISTRIBUTION IN THE TYPE S PURIFIER.
CENTRE OF COMPARTMENT
UPWARD AIR VELOCITY
0 2 4 6 8 10 12 14 16 18
POSITION ACROSS SIEVE (INCHES)
NEAR DIVISION PLATE.
UPWARD AIR VELOCITY
0 2 4 6 8 10 12 14 16 18
POSITION ACROSS SIEVE (INCHES.)

Figure 5

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sieve motion on the rate and regularity of travel of the stocks.

As the work has proceeded we have also been able to compare in typical cases the behavior of the experimental machine with an adaptable form of full scale purifier erected in our experimental mill.

In illustrating the more important results of the experimental tests we have for convenience constructed graphs to show increasing bran contamination (bran index) of the accumulating fractions against the yield of separated material as a percentage of the feed.

For these graphs the horizontal distances show what percentage of the feed has been passed through the sieves by the end, for example, of the first, second or third covers, etc. For each such position the vertical distances show how far the bran in the feed has appeared in the separated fractions. All the graphs must start at the origin and finish at 100% yield. A straight line between these points, like the one shown dotted in Fig. 1 would mean that the bran in the throughs was strictly proportionate to the amount of throughs and that the machine had no separating capacity whatever. When stock is purified, however, the curves fall below the line and in general the lower they fall the better the quality of the separation. In judging the merits of various purifier arrangements, the best advantage lies with the arrangement giving the curve which lies lowest—particularly during the early and middle separations from the machine.

Fig. 1 shows the effect of air quantity through the stock on the nature of the separation. All stock was I and II Break Middlings tailing 36W and the graph shows how far the separation is improved by the presence of air. Note that no air at lower speeds makes a bigger difference than no air at higher speed.

Fig. 2 shows the effect of feed rate on separations made of coarse middlings on a machine run at 7/16 inch stroke and 450 r.p.m. on a tinless machine provided with two decks of sieves. The results show a distinct advantage for lower feed rates but nevertheless reasonable purification at 2,600 lb./hr. on a sieve 18 in. wide.

Conclusions Drawn

What sort of conclusions have we been able to draw from these various tests? It is most important that the oscillatory motion of the sieve should be smooth and yet correctly provided with the slight upward "kick" necessary to make the stock free running. Suitable sieve motion is best achieved by attention to the driving mechanism of the sieve and particularly to the complete balancing of the oscillatory forces. If the

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Diagram of operating design of filter tube. (Available in multiples of 4, 8, 12, 16 & 32)

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stock is to cover evenly the width and length of the sieve, the mechanical motion must give good conveying action to the stock. If, as is sometimes the case, the speed and stroke are too small to give good conveying action in the absence of air, then the stock travels fast only where the air flows fully and patches of heaped, slow moving stock are to be found wherever the air flow is restricted—as, for example, towards the sides of the sieve or at junctions between covers. The result is that air bursts through at some points and stock bunches badly at others.

It is, therefore, desirable, particularly with the sluggish stocks at the tail end of the break system or with particularly fine stocks, to make sure that the vibratory conveying action alone of the sieve is sufficient to convey the stock evenly.

As with all sieving machines the capacity of a machine should properly be expressed in terms of the quantity of throughs which can be effectively handled by the machine. It may be possible to feed at very high rates to a purifier and successfully carry the stock to the outlet ports; if, however, the feed rate is too high the sieve cover may be overloaded in respect of sieving capacity or covers may have to be too open; in either case purification falls off in quality. Too much good stock may find its way towards the tail of the machine. The effect of the air currents will moreover be seriously reduced and there will be a general loss of efficiency all around.

This point can best be illustrated as follows: In the case of Middlings from I and II Breaks tailing 36W the rate of sieving is determined by the cover size, the depth of stock on the cover, the degree of agitation of the stock and the upward strength of the air current. The graph Fig. 3, shows the manner in which the weight of throughs expressed as pounds per hour per square foot, increases with depth of stock on the cover for a stroke of 7/16 inch, a speed of 450 r.p.m. and an air flow of 30 ft./min. through the cover. The dotted line shows the relationship for a speed of 650 r.p.m. At the lower speed, all depths of stock greater than 1/12 inch lead to much the same rate of throughs. At a higher speed the saturation depth is much the same though the rate of throughs is rather greater. Generally if the air quantity is reduced the saturation rate tends to increase but naturally the quality of the stock deteriorates. Once, therefore, the air is set at the optimum value for aerating and stratifying the stock, increase of feed rate to the machine does not lead to a corresponding increase in well separated stock through the cover. Some stock potentially able to pass through the cover will inevitably find its way towards the tail end of the mill.

We should expect to find, therefore, that for a given purifier feed rates greater than a certain optimal amount will lead to a rapid deterioration in performance of the machine. That this is so is clear both from quality tests carried out on a full scale machine and from tests of similar sort carried out on the laboratory purifier.

The quality of separated stock deteriorates steadily when the feed rate rises above 2,640 lb./hr. for I and II Break Midds. and above 1,120 lb./hr. for IV C stocks. Extensive tests have shown that this state of affairs is not necessarily improved by increasing the severity of the motion of the sieve. For example, for No. 1 Middlings at high feed rates and a stroke of 7/16 inch, increase of speed above the optimum figure causes a deterioration in purifier performance. This is shown in Fig. 4.

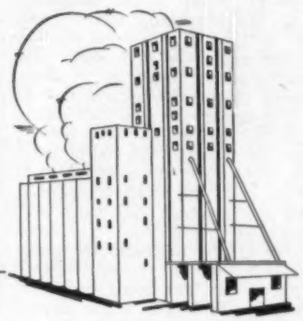
Arrangement of Sieve

Several arrangements of sieve are to be found amongst the purifiers available today. The simplest form of purifier has a single deck sieve. Other purifiers have double and even treble layers of sieve cloth. In some types of purifier, spaced collecting tins are arranged above the sieve cover and serve to keep fine, branny stock lifted by the air currents from falling back on to the sieve covers. If a purifier is provided with suitable covers and can be correctly set to give a smooth, steady motion, good coverage and travel of stock and is carefully designed for a uniform distribution of air, then satisfactory separations will be possible with single or multiple deck sieves, with or without tins.

The problem has always been how to achieve the most uniform distribution of the air, for it is upon this factor that good coverage and travel of stock very largely depend. In a machine having a large expansion chamber above the sieve, in my company we have always held the view that stationary tins placed across the sieve provided the surest means of distributing the air uniformly; at the same time they made possible an additional separation of light branny stock lifted by the air currents.

However, increasing labor costs are driving both the machinery designer and the miller towards simpler constructions which will be easy to supervise, clean and maintain. We have, therefore, been working for some time on a type of hood above the sieves which would provide even distribution of air without tins, but at the same time be low enough to prevent stock falling back on to the sieve once it has been lifted by the air currents.

We felt that if the problems of design could be solved, a much lower



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machine would be possible and the upper deck of sieves could be clothed to provide a separation of light branny stock approximating to that previously collected in the tins. A lower machine would not only make the flow of stock easier to see and be easier to clean, but it would permit machines to be mounted two high where space is particularly limited or for durum milling where extensive repurification is necessary.

Clearly, however, such a radical modification in design could not be accepted if it would result in a serious loss of efficiency.

Many detailed measurements and tests were necessary to find the most suitable shape of low-type hood. The excellence of the air distribution comes of attention to the detailed shape of the hoppering below the sieve as well as of the hood itself. Fig. 5 illustrates the uniformity of air velocity across the width of the sieve cover in the design finally selected. The upper curve of each pair refers to the distribution in a compartment towards the tail end of the machine, whilst the lower curve refers to the head end of the machine.

In the new machine, the hoods or air chambers are inclined towards the center of the machine, so that one can look down on the full width of the sieve cover. The hoods are subdivided along the length of the sieve by eight partitions to ensure the best air setting and distribution at all points. From the hoods air passes through regulating valves to a central exhaust chamber at the top of the machine. At this highest point, the machine stands only 3 ft. 6 in. from the floor. The main frame, double-deck reinforced sieves, and shaker conveyors follow very closely the lines of the Type "R" purifier containing tins; this model will remain available for purposes where tins are considered to be of special value.

The standard machine has two layers of sieves; each layer is made up of four interlocking sectional sieves, which slide in grooves in the supporting frame. Automatic sieve brushes are mounted under each cover and sieve frames are specially reinforced where heavy loads have to be handled.

Each sieve is driven from its own eccentric mounted on a common shaft at the head end of the machine. The machine is balanced by driving through a third eccentric, in opposite phase to the sieve eccentrics, a counterweight which equals the combined mass of the sieves and their attachments. The counterweight is supported on hangers so that it lies centrally along the machine just below the common exhaust trunk.

The throughs of the covers fall into hoppers which are suspended from vertical links so as to lie immediately below each sieve and which are vibrated horizontally through rods connected to their respective sieves. At the bottom of each collecting hopper lies a double all metal trough; one channel is inclined downwards towards the head and the other towards the tail end of the machine. Turnover flaps can be set to direct the falling stock into either of the two channels so that the stock may be delivered towards either end of the machine. The outlets of shaking conveyors and for overtails are fitted with a new type of vibrating metal spout registered under the name Rotatube. This consists of two rubber rings and a piece of aluminum spouting so arranged that a dust and bug-proof connection can be fitted to a rotating or vibrating machine.

The opening of the feed gate is controlled from a balanced level detector in the form of a vertical spindle with radiating spokes lying in the feed spout and it is, therefore, self-regulating. The vibrating shoe which feeds the stock through the gate is driven through a spring link system from its own sieve.

The construction of the machine gives very good visibility to the interior.

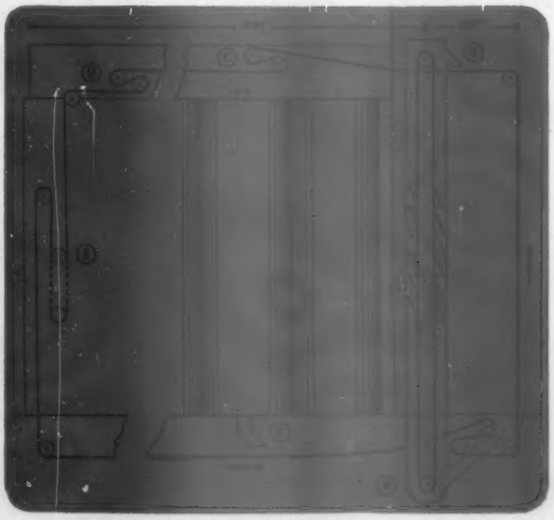
The sieves on which the feeds fall are fully open to view through the windows which form the top of each hood; the transparent panels slide sideways to give access to the space above the sieves. This makes it simple to clean the interior of the machine and to see the stock at all stages of its travel along the sieve. Ledges where stock can lodge and bugs breed have been reduced to the very minimum.

The special method of balancing the machine gives smooth motion to the sieves. The eccentrics give a stroke of 7/16 inch and each sieve is mounted from hangers which are adjustable in angle to give the correct amount of kick independently on the two halves of the double machine. The standard speed of the machine is 485 r.p.m.

The smooth oscillating motion assists the fluidizing action of the air so that an even flow of stock can be achieved without bare patches and with a relatively small air current particularly suited to the purification of a light clinging feed. A single side of the machine will give efficient purification with a feed of 2,640 lb./hr. of I and II Break Middlings or a feed of 1,120 lb./hr. of IV C stock.

As a result of most careful tests a purifier hood has been developed

Entirely equipped with "U. S." Belting



But the size and approximately 20-million-bushels capacity of this C-G Grain Company elevator* (Wichita, Kansas) is not what principally amazes grainmen. They marvel most at the ultra-modern method of handling the grain: The belting installation makes it possible to unload from incoming cars or load an outgoing car, and "turn" grain to aerate it—all in simultaneous operations, each of which does not interfere with any other.

• Upon arrival, the grain (in rail car or truck) is emptied onto United States Rubber Conveyor Belts, which carry it rapidly to the "leg". *Valuable time is saved.*

Example of C-G Belting Operation

Grain is discharged into boot (A). From here, elevator belt carries it to headhouse where it is discharged onto conveyor belt (B). Grain is conveyed along top of bins where movable tripper (C) discharges it into proper bin. Belt, powered by 100 h.p. drive (D), then drops 125 ft.—through gravity take-up pulleys (E)—returning along bottom of bins where reverse side of belt receives grain discharge from any of the bins it serves (F).

US RUBBER

which provides good air distribution in a much lower machine. The result is improved visibility, simplicity and ease of construction, cleanliness and maintenance. At the same time the machine can handle a higher capacity with good efficiency and a considerable saving in space.

—BREAD IS THE STAFF OF LIFE—

NEW FEED MILL

CINCINNATI—A site has been selected and plans are being drawn up for a new Provico Feed mill at Guntersville, Ala.

Completion date and exact details of the mill have not yet been set.

MOISTURE TESTER

(Continued from page 5a)

racy could be sacrificed in order to secure speed. It was therefore thought worth while to turn again to the simple principle of measuring the electrical resistance between electrodes plunged into the grain. This system had been shown by several early investigators (e.g., Briggs in 1908 — "An Electrical Resistance Method for the Rapid Determination of the Moisture Content of Grain." U.S. Department of Agriculture Bureau of Plant Industry Circular No. 20, and Zeleny in 1909—"An Electrical Method for the Measurement of the Amount of Moisture in Grain and other Materials." The Minnesota Engineer, 17, 163-170) to give a useful measure of moisture content, but was abandoned by them on the grounds of its inaccuracy.

Electrode Probe

A good deal of experiment led to the design of a form of electrode probe which gave results much more repeatable than those obtained by earlier workers. It consists of nine steel spears, each 8 in. long, arranged parallel to each other on an insulating base and cross connected.

It was found that accuracy could be improved by making measurements at a fairly high voltage (500 v) and most fortunately a robust instrument for measuring resistances in the necessary range, using this voltage, already exists. This is the "Megger" insulation tester, a widely used instrument which generates its own current at the turn of a handle. The smallest model, known as Series 3, or the "Wee Megger," was found to be entirely satisfactory for the purpose.

About two years ago a prototype moisture tester consisting of the newly designed electrode probe in combination with a specially calibrated "Wee Megger" was made at this laboratory, and used over a wide range of conditions and in several different kinds of grain. It proved to be exceedingly useful in practice and has now been turned over to an agricultural engineering firm for commercial production. (Scottish Mechanical Light Industries, Ltd., Scot-Mec Works, Ayr, Scotland.)

In spite of the improved electrode probe, and the high voltage at which resistance measurements are made, the new moisture tester is less accurate than some others on the market. While most readings obtained are well within ½% of the true value, variations up to 1% from the true value occur. This, however, is largely compensated for by the ease with which two, three or more determinations can be made in a single sack in five to ten seconds. The average of such a group of moisture measurements is considerably more reliable than a single one, so that speed makes it possible to get a better over-all accuracy than would be obtainable with an intrinsically more accurate meter working on a single test sample.

The range of the meter is from just below 12% moisture content up to 24 to 25%. In a hot climate, however, readings can be obtained down to or below 11%.

With this instrument it is possible to test every sack in a lorry load in a few minutes, without opening a single sack. It is easy to decide whether it is an even or a very mixed lot, and to set on one side or reject the occasional very damp sack.

Used for Bulk Grain

Although developed primarily for grain in sacks, it can also be used in bulk, but the short reach of the electrodes, which are only 8 in. long, limits its usefulness in deep bulks. The minimum sample which can be tested is about half a gallon (say 4 lb. of wheat) which must, for this purpose, be placed in a cardboard tube container about 4 in. in diameter and 10 in. deep.

The scale of the instrument is valid for wheat, barley, maize, rye and oats. Malting barley readings, however, need to be corrected if they are to agree with results obtained by the standard maltster's moisture method. Temperature has a considerable effect on the readings, and the standard scale is prepared for a grain temperature of 60° F. It is necessary, when the temperature differs greatly from 60° F., to make a temperature correction, and for this purpose a simple chart has been devised and will be incorporated in commercial models. For tropical use it is probable that the instrument itself would be fitted with a scale calibrated for 80° or 85° F.

• At the leg U.S. Elevator Belts take the grain to the top of the head house, where the U.S. conveyor belts distribute it to the bins. Then they disappear into the floor, descend 125 feet, and use their reverse side to take grain discharge from the bins for shipment or aeration. *The one continuous belt does two jobs.*

In all, over 12,000 feet of "U. S." belting is used. U.S. Rubber belting engineers designed and built the belt for this revolutionary system, working with the engineers of the grain elevator builders and the engineers of the conveyor equipment builders. This is the widely-known "U. S." *Three-Way Engineering* method. *Savings in time and money beyond calculation.*

The belts in this elevator are of the famous cotton-nylon construction—developed by "U. S."—which increases tensile strength up to one-third for the same number of plies of standard duck... gives greater troughability to conveyor belts and better bolt holding ability to elevator belts.

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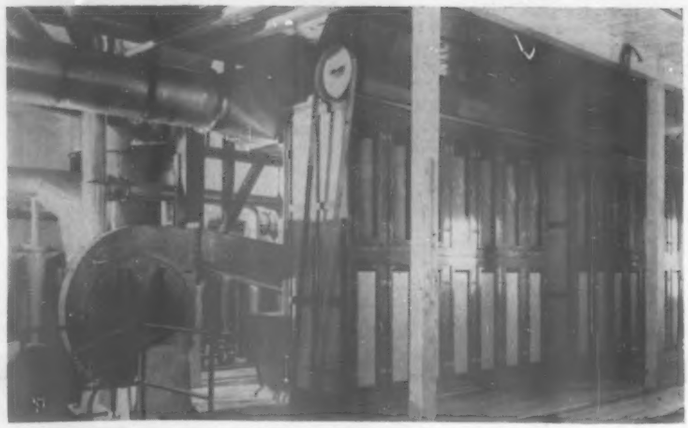

DUST COLLECTORS—This picture shows the two new Robinson filter sleeve dust collectors and one of the fans serving the "Pneu-Flow" system. Every minute 14,000 cu. ft. of clean exhaust air leave the dust collectors and may be directed back into the mill to economize on the heating system in winter.

MODERNIZATION

(Continued from page 3a)

Mr. Ellison came from Utah and his first project was the erection of a sugar mill at Raymond in association with Jesse Knight. The possibilities of the wheat flour milling business attracted him and he returned to Utah to raise $35,000 among his friends. He engaged George W. Green as manager of the venture and organized the Raymond Milling and Elevator Co., Ltd. The plant, Alberta's first roller flour mill, started up in January, 1903. The project was successful and it was decided to expand, fast-growing Lethbridge being chosen as the site for a new mill. The new Ellison company took over the Raymond interests and a four story flour mill, with a capacity of 300 bbl. a day, was constructed. The premises also included a two-story warehouse and a 50,000-bu. elevator.

Mr. Green continued as manager of the company until 1935 when he was succeeded by Morris H. Ellison, son of the founder. He was succeeded by the present manager, Read C. Ellison, grandson of the founder. Douglas Paterson is head miller.

Supervising the remodeling was George Hayward, Robinson representative in Canada. Other members of staff on hand for the work were James McLean and Henrik Gardberg.

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Mill Cost Study Explained; Control System Described

The attention being given to costs these days was evident in two talks at the 1955 Midwest Feed Production School — one dealing with operating costs and one with a cost control program.

Dr. V. John Brensike, U.S. Department of Agriculture economist, explained how some of his research findings on feed mill costs can be used to stimulate interest in better cost records, make cost comparisons with other plants, help find areas of high cost in any plant and supplement one's own information when new plants or expansions are planned.

In describing some of the results of his study, he related findings to small plants (averaging 2,200 tons a year), medium plants (31,000 tons) and large plants (81,000 tons). These three types had total operating costs averaging, respectively, $16.43 per ton, $10.98 and $9.14. These costs included all costs of operating the business except ingredients, bags, tags and similar materials, and profits.

Data on labor in production showed man-hours per ton averaged, respectively, 5 hours and 41 minutes, 2 hours and 42 minutes and 1 hour and 54 minutes. Volume of operation, when used as a separate factor, explains 63% of the variation in labor inputs. This doesn't necessarily mean that volume alone explains the variation; rather, it means that variations are explained by volume and related factors such as proportion of capacity used, age of plant, etc.

Regional Data

Regional data showed that southern plants in a certain tonnage range required almost 2 hours more of work to produce a ton of feed than were required in other areas. This may be caused by less mechanization and/or lower labor productivity.

In addition to having higher per ton operating costs, small mills' investments in plant and equipment are larger per ton—$22 against $7 for the large plant.

However, while some small plants have been dropping out, others are coming in and the small operators are just as willing as others to modernize and improve. Dr. Brensike said many small manufacturers have inherent locational, service and managerial advantages that make them a continuing part of the business. However, they must adopt modern practices, know their products well and serve the farmer well.

Cost Control Program—A good cost accounting system and a daily cost control program are very valuable in today's competitive market, said Lowell Judd, Albers Milling Co., Kansas City. Mr. Judd was ill at the time of the production school, and his paper was presented by Max Shields, Albers' Kansas City manager.

Mr. Judd described a cost control system which his company adopted some years ago. It provided, among other things, so that all charges (fixed and indirect and direct labor) could be charged to any commodity processed as it progressed through the mill—for example, the cost of producing a ton of mash, covering receiving, grinding, mixing, sacking off, loading.

Labor code sheets were prepared, with a code number for any job, and this simplified reporting of labor for the various "systems" in a mill. Forms also were provided for reporting production. The whole plan provided a simplified procedure. This information, along with other data, is used to make labor cost comparisons.

Each plant monthly gets a cost breakdown for each operation—for example, packing costs, broken down to different sizes and types of feed. However, for a good control system, daily figures are necessary, and these are provided for certain key operations—such as mixing, packing, shipping and receiving of various types or methods. These data are put on a daily standard cost form which shows: operation, total tons, total labor cost, actual cost per ton and standard cost per ton (a predetermined figure). This information is used to correct any problems.

While small operators can't have elaborate coding and standard cost systems, they can use simple methods. For example, one small firm determines the daily cost per ton by dividing total labor cost by total tons. This figure is plotted on a graph to show the over-all trend.

It is necessary to control indirect costs, too, such as maintenance supplies and indirect labor. The most practical method, Mr. Judd said, is through budgets for each item.

——BREAD IS THE STAFF OF LIFE——

Sales Representative

WORCESTER, MASS.—William S. Johnstone has been appointed sales representative for South Carolina and east Georgia by the Graton & Knight Co., Worcester, manufacturer of leather belting and other industrial leather products. He formerly was with the Ragan Ring Co. and prior to that with H&B-American Machine Co. and the Carter Traveler Co. as a sales representative. His headquarters will be in Greenville, S.C.

Advertisement

INSIDE SCIENCE

The Vital Story of BREAKFAST CEREALS

with essential vitamins and minerals restored

by Science Writer

This article is one of a series devoted to the story of vitamin enriched or restored cereal products: white bread and rolls, white flour, corn meal and grits, macaroni products, white rice, breakfast cereals, farina.

Increasing in popularity over the years, breakfast cereals are used throughout the United States by young and old alike. Eaten with fruit and milk or light cream, they contribute an excellent combination of basic, flavorful, nutritious foods to the diet.

In the past decade the use of these fine foods has grown markedly. In fact, it is estimated that there has been a 20% increase during the period. In 1953 the increase was much higher than the average of previous years. It was 5.5%.

During 1953, for example, many tons of breakfast cereal foods were eaten in the United States. Industry figures show that 4.6 pounds of dry cereals and 2.5 pounds of hot (cooked) cereals per person were consumed.

Many grains are processed to make breakfast cereals: wheat, corn, rice, oats. Often these foods may be eaten just as they come from the manufacturer's package. Or they may require only a short period of cooking to be ready for the table. They appeal to busy home-makers, as well as to institutional dietitians, because they are readily available in a variety of flavors to add interest and value to an important, but sometimes neglected, meal.

A Nutritional Advance

As the science of nutrition advanced in recent years, it was found that losses of essential vitamins and minerals occurred during processing of wheat, corn and rice into breakfast foods. When this became known, most manufacturers acted to overcome the losses. They adopted restoration.

Restoration simply means that certain vitamins and minerals are added to the cereal food during processing so that the finished product is generally equal to the whole grain values of those elements. The vitamins thiamine (B_1), riboflavin (B_2), and niacin as well as the mineral, iron, are used in restoration. Vitamin D is also added sometimes.

The recent trend toward pre-sweetened cold cereals for breakfast consumption and between-meal snacks emphasizes the nutritional importance of vitamin fortification. Increased calories require more "B" vitamins for proper utilization.

What the Vitamins Do

Thiamine is the vitamin which helps to build and maintain physical and mental health. It is essential for normal appetite, intestinal activity and sound nerves.

Niacin, which is another of the "B" vitamins, is needed for healthy body tissues. Its use in the American diet has done much to make a serious disease called pellagra disappear.

Riboflavin is the vitamin which is essential for growth. It helps to keep body tissues healthy and to maintain proper function of the eyes.

Vitamin D is important to prevent rickets in children and the development of certain abnormal bone conditions in adults.

Iron is essential for making good red blood and for preventing nutritional anemia.

Where Do The Vitamins Come From?

At about the same time that processing losses in breakfast cereals became known, other developments in the science of nutrition produced ample supplies of vitamins at economical prices. Thus, the quality of breakfast cereal foods could be, and was, greatly improved through restoration.

Since the early days of breakfast food restoration and of white flour and white bread enrichment, the world-famous firm of Hoffmann-La Roche has supplied top quality vitamins by the tons. Pioneering work in its laboratories and by its collaborators resulted in the "duplication" of some of Nature's extremely complex substances. First, the chemical composition of the vitamin was learned. Second, the pure substance was isolated. Third, the "duplicate" was made by synthesis. And fourth, the laboratory techniques were extended to large scale operations.

The manufactured "duplicate" is identical chemically and in biological activity with Nature's own product. A vitamin is still a vitamin regardless of its source. So efficient is large scale manufacturing that vitamins are sold at a lower cost than if they were extracted from natural sources.

Reprints of this article, and of all others in this series, are available without charge. Please send your request to the Vitamin Division, Hoffmann-La Roche Inc., Nutley 10, New Jersey. In Canada: Hoffmann-La Roche Ltd., 286 St. Paul Street, West; Montreal, Quebec.

Worth Looking Into

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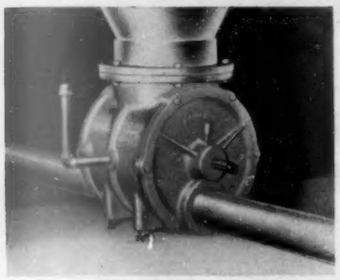
New Literature

This reader service department announces the development of new and improved products, new services and new literature offered by manufacturers and suppliers. Claims made in this department are those of the firm concerned. Use the accompanying coupon to obtain the desired information.

No. 5345—Airlock Feeders

Prater Pulverizer Co. recently unveiled a new design on its Blow-thru Rotary Airlock Feeder. The new feeder is claimed to meet the varied and exacting needs of high or low pressure systems in the process industries. The Rotary Airlock is said to feed practically any type of pow-



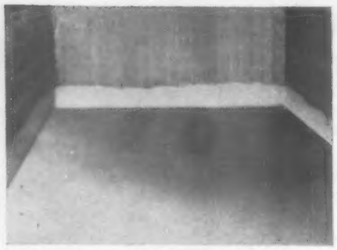
dered or granular product into pneumatic conveying lines, while functioning as a working seal to sustain differential pressures. It also seals off air at the bottom discharge of bag filters, spray dryers and especially dust collectors, removing the dust from these systems while it is being collected. The units are serving in applications which range from removing fine dust from cyclone collectors, to feeding finely ground products into pneumatic conveying systems. For further information, check No. 5345 on the coupon and mail it to this publication.

No. 5350—Magnets

The H. C. Davis Mill Machinery Co. announces the introduction of a new-type hopper magnet to its line of permanent magnets to remove iron contamination from free-flowing feeds. The disc-shaped magnet consists of a series of steel discs spaced at 1 in. centers with cylindrically shaped, Alnico V permanent magnets occupying the spaces between the discs. The steel discs serve as pole plates for the magnets and have been designed to cause symmetrical and efficient distribution of the magnetic field over the most effective areas, the company states. The unit can be used in sloping hoppers and other locations with proper supports. It will perform in either wood hoppers and other locations with proper supports. It will perform in either wood or steel hoppers. Secure more complete details by checking No. 5350 on the coupon and dropping it in the mail.

No. 5330—Boxcar Coating

Armortex is the trade name for a plastic base material which can be applied to boxcars to make them suitable for grain, grits, flour, and other materials, announces the J. W. Mortell Co., manufacturer of the



product. New literature concerning the product states that it is a mastic material which can be applied to a car floor in less than 30 minutes or

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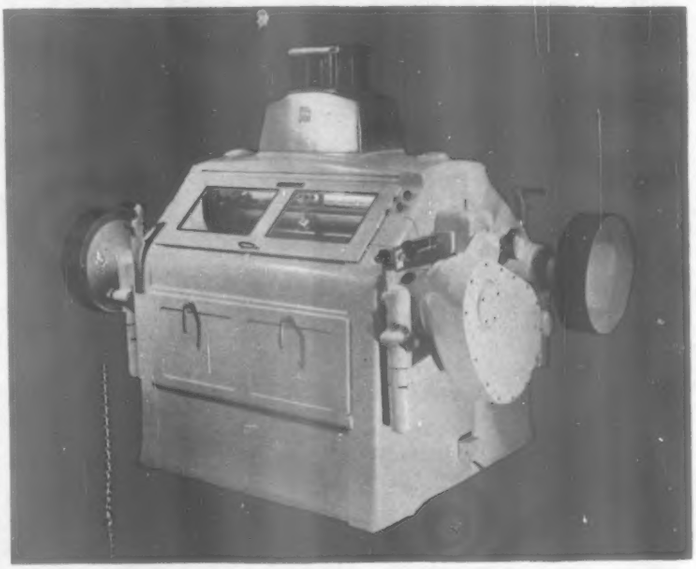

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to all wood surfaces in about three hours—readying the car for service the next day. The product is claimed to be resistant to abuses, stains and discolorations and a ⅛-in. thick film may be bent around a 1-in. mandrel without cracking. It may be applied by spray, brush, trowel or squeegee and is said to present no fire hazard. Secure available literature by checking No. 5330 on the coupon and mailing it to this publication.

No. 5328—Multiwall Bag Tape

A pressure-sensitive tape for patching multiwall bags has been introduced by the Behr-Manning Division of the Norton Co. The tape, made in 60-yd. rolls, comes in 2- or 3-in. widths and has a tensile strength of 45 lb. and an adhesive grip of 65 oz. per inch of width. The tape patch is applied directly over the tear or hole in the multiwall bag. A manufacturer of pesticides reports savings of 50¢ on each repair and a large feed manufacturer has supplied each of its dealers with tape to mend torn bags. Additional information about the tape may be obtained by circling No. 5328 on the coupon and mailing it to this publication.

RUSSIAN MILLING

(Continued from page 1a)

duced at Mill No. 73 in the town of Dniepropetrovsk (4.75 m/s = 360 r/m for a 9 in. roll). At the same time the American method of bran-dusting was introduced using an American type machine with vertical brushes constructed on the spot at Dniepropetrovsk. Thereafter this mill began to produce three sorts of high milled flour. Its capacity rose to 82 tons from the 57 tons (900 to 1,300 cwts.) per 24 hours original capacity without harm to the old-fashioned roller mills which had simple sleeve bearings and which were manufactured in 1890 by the German firm of Luther.

Reports of these experiments were submitted repeatedly to the directorate of the "Ukrchleb" and "Chlebprodukt" (trust for mill supervision) and also to the Scientific and Technological Soviet "Narkomtorg" (People's Ministry of Trade) during 1927-1928. They were also published in a book, "Analysis of Milling Balance" by Engineer Levinson, but in spite of this the project seemed to bog down.

Finally in 1928, Mill No. 78 in the town of Zaporojdye was taken over for further experimentation with American roll speeds. The aim was to conduct experiments at a regularly operating plant and to introduce speeds of 7 meters per second (525 r.p.m.) in both the break and reduction systems. High speeds on reduction rolls with equally high speeds for break rolls were thus introduced for the first time in the USSR and thereby also for the first time in Europe.

Mill No. 78 in Zaporojdye was chosen for the following reasons:

1. It was not too large a plant but it did have a sufficiently modern mechanical installation.
2. Its territorial location was in the center of the Ukrainian milling region where the wheat supply is of medium quality and thus it would probably provide the most representative results.
3. Its proximity to the Combinat (breadstuffs production center — including grain storage, mills, bakeries, etc.) which was being constructed at that time in the town of Dniepropetrovsk. It was hoped to attract the attention of engineers engaged in its construction to these new experiments, with a view to having the re-

Blaine L. Sidders

JOINS SUPERIOR SEPARATOR—The appointment of Blaine L. Sidders to the position of special representative to terminal elevators and the malt industry has been announced by I. S. Willis, general manager of the process machinery division of Superior Separator Co., Hopkins, Minn. Mr. Sidders previously was superintendent of the Electric Steel Elevator Division of the Russell-Miller Milling Co., Minneapolis. He was with that firm for 28 years, in elevator operations in Duluth and Minneapolis. In his new position, he will be in charge of sales of Superior's cleaning and processing machinery to the terminal elevator and malt trades.

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sults applied, if successful, in the construction of the Combinat.

Mill No. 78 had been built in 1913 by the firm of Ame, Gissike and Congen, and had 8 roller mills 800 x 250 mm. (10 in. x 32 in.) in size. Before the introduction of the American speeds it processed 30-35 tons of wheat in 24 hours (480-560 cwts.), producing three grades of flour. Following the remodeling to the American system this mill began to process 60 tons of wheat for 24 hours (960 cwts.) and the same three grades of flour, on the same roller mills.

The significance of this experiment was enhanced by the fact that these positive results were achieved on machines of European construction which were in addition 15 years old. This suggested the possibility of reconstructing all existing mills in the USSR to the American method.

The Zaporojdye experiment was conducted on non-uniform wheat, of which 6,000 tons were milled. Replicate millings were executed at regular intervals with varying speeds of the break rolls, at varying loads, with different break releases as well as with different wheats. This made it possible to evaluate the milling operation not in its individual parts, but as a whole, and to note the advantages and disadvantages of the system. Altogether 10 milling investigations were carried out with speeds of 7 meters per second at loads of 195, 165, 140 and 110 kilograms per hour per meter of roll surface. In addition three millings were executed by the system of Edgar Miller at 7 meters per second (550 r.p.m.) with a loading of 165 kilograms per hour per meter of roll surface (equivalent to 4½ bu. per hour per 30 in. roll surface). One milling was carried out with Siberian grain as well as one operation at the restored European speed of 3½ meters per second with a loading of 111 kilograms per hour per meter of roll surface. The data for these experimental millings indicating projected and actual production figures are given in Table 1.

In addition to the data shown, 58 regular industrial millings were performed.

The grain was cleaned during these experiments by the intensive European method with four scourers, 40 hours of heat conditioning and two temperings. This kind of cleaning and preparation may not have been suitable in view of the subsequent processes to which the grain was subjected. It is essential to condition the grain without weakening the bran coat and for best results, cleaning and preparation of the grain should also have been done according to milder American methods. Scouring according to European techniques at the Zaporojdye mill, when followed by an American break system, weakened somewhat the results of the experiments. Thus, for example, the ash content of the flour obtained was higher than American-type flour. It was decided therefore to carry on further work using American-type grain cleaning machines according to American methods.

The flow sheet was based on 5 breaks and 10 reductions with American bran dusting machines and centrifugal dressing machines for finishing up. The flour was passed through sieves not coarser than No. 11. However, in addition to these characteristics of American flow sheets, greater sieving surface was used, namely: 44 square meters per 16.4 tons of wheat capacity (100 Russian poods equals 16.4 tons). These experiments did not succeed in solving the problem of reducing the sieving surface requirements to American levels, which are considerably smaller (about half) of the amount indicated. Otherwise, in all of these experiments, the roll speed of 7 meters per second was completely successful on the break system (differential 2.5:1) and on the reduction rolls (differential 1.5:1). The grooves on the corrugated rolls were similar to the Dawson type and were operated with blunt edges fitted together (dull to dull). Operation of the smooth rolls at the differential of 1.5:1 with high peripheral speeds produced no flattening or flaking of the flour in the grinding process which is characteristic of European reduction systems. As a result the capacity attained 44.5 kilograms for 24 hours per centimeter of corrugated roll surface and moreover the roller mills worked quite smoothly. By the end of the second year of operations at this mill, capacity attained 52.9 kilograms for 24 hours per centimeter of roll surface. When balanced, the break releases with this system were: I.—25%, II.—30%, III.—15%, IV.—8%.

Table 2—Production and Ash Content of Break and Purifier Stock Using Various Experimental Systems

Mill number and System	Middings stocks large	Middings stocks medium	Middings stocks fine	Tailings*	Total midds.	Break flour	Mean ash content: Purified midds.	Mean ash content: Flour	Ash content in original grain
	%	%	%	%	%	%	%	%	%
1, normal	20.2	20.7	12.7	8.5	60.1	13.7	1.21	0.89	1.87
2, normal	20.9	14.1	11.5	12.0	58.5	16.5	1.59	0.99	1.90
3, normal	20.1	20.9	16.3	...	57.3	14.5	1.49	0.90	1.85
4, normal	3.6	19.5	19.1	...	47.2	15.8	1.09	0.80	1.69
Q†=200, V‡=6.8	21.0	8.0	21.5	10.5	61.0	12.6	1.16	...	1.65
Q=175, V=5.3	18.8	18.8	4.6	9.5	51.7	12.9	1.24	...	1.60
Edgar Miller	14.7	5.4	23.0	10.0	53.1	10.7	1.08	...	1.78
Restored European	31.1	23.4	5.3	5.5	65.3	8.1	1.11	...	1.78

*Stock from tailings rolls after brushing and centrifugal machines yielded 3% of first grade flour, 8% second grade and 5% third grade with rather low ash content.
†Q—Loading in Kg./hr./m. roll length.
‡V—Peripheral roll speed, meters per second.

Quality of Products

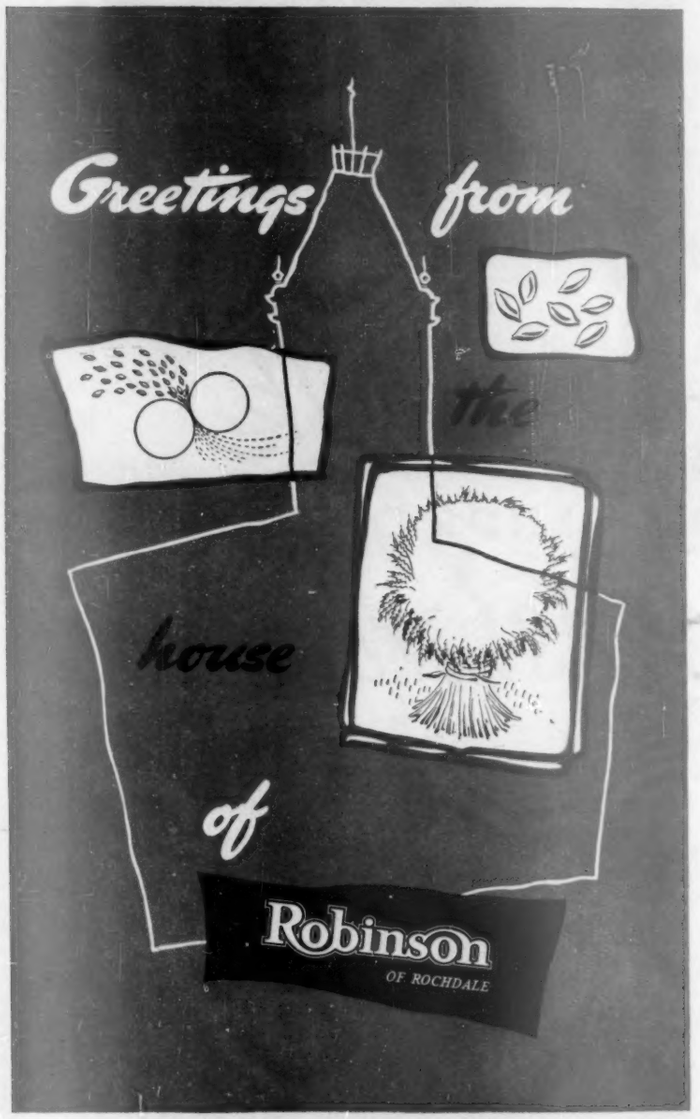
The over-all quantity of break middlings (prior to purification) reached 55% with an average ash content of 1.05%, with the production of smaller amounts of coarse and medium middlings and more fine middlings when compared with European milling. Comparative figures on the purified break stock from the experimental millings are shown in Table 2.

After passing through the brush and centrifugal dressing machines, flour produced on the final reduction roll consisted of: first quality, 3%; second quality, 8%; third quality, 5%; all three had a rather low ash content. The test weight of grain varied from 73.2 to 77.0 kilograms per hectoliter.

Yield of first quality flour (Sickle) was 46%-53% with an ash content of 0.51%-0.58%; second quality (Hammer) was 15% to 22% with ash content of 0.75%-0.96%, and third quality (Wheat Stalk) 5 to 6% with an ash content of 1.2%-1.8%. The over-all flour extraction reached 72-76% with an average ash content of 0.7% to 0.8%. Such high production of best quality flour was due to the fine milling and fine sieving. Certain inferiorities in these products as compared with American quality standards can be explained by (1)

Table 3—Technical Characteristics for Flour Mill With Capacity of 200 Tons Wheat Per 24 Hours, According to American, German and English Specifications

Characteristic:	American	German	English
Working length of break rolls (cm.)	1,950	5,100	5,070
Working length of reduction rolls (cm.)	3,048	5,550	7,930
Total roll working length (breaks & reduction) (cm.)	4,998	10,650	13,000
Number of detacher machines	3	25	36
Ratio of length, breaks to reductions	1:1.56	1:1.108	1:1.56
Peripheral speed, fast break rolls, m./s.	6	3.66	4.6
Peripheral speed, fast reduction rolls, m./s.	6	2.94	3.0
Rotating surface of fast break rolls (length x velocity, m.²/s.)	102.5	39.4	39.4
Total capacity of break and reduction systems, Kg./cm./24 hrs.	40	18.8	15.4



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absence of rounded grooves of corrugated rolls as used in American methods, (2) insufficient heat conditioning of the grain, and (3) inappropriate cleaning of the grain which was done according to the European method.

Granulation analysis of the flour in terms of percentage of sample passing through a No. 15 sieve was as follows: First quality flour 67%, second quality flour 56% and third quality flour 25%.

These figures were much higher than for other mills including those of higher capacity which operated on the same wheat mix according to the European system.

Analysis of the data for the 10 experimental millings established the following facts:

1. With speeds of 7 meters per second on break and reduction rolls capacity was reached of 44.5 kilograms per centimeter of roll surface per 24 hours.
2. With reduced loading at the same speed, the efficiency of milling did not improve.
3. At reduced speed the capacity was reduced correspondingly and at European speeds of 3.5 meters per second a capacity of 25.6 kilograms per centimeter of roll surface is obtained, which is 75% less than with American speeds.

Analysis of power consumption during these 10 experimental millings established that to attain a capacity of 16.4 tons (1,000 poods) milled at the rate of 44.5 kilograms per centimeter of roll surface, 42-44 horse power was used. This figure did not exceed even the lower averages of mills of European type in spite of the fine granulation of the products from Zaporojdye mill. This result was due to a reduction of power used by idle machines prior to loading, as well as greater efficiency in the use of power during loading.

Summary of Operational Data

The following is a concise summary of the operating data obtained:

1. Peripheral roll speed: 7 meters per second.
2. Capacity: 44.5 kilograms per centimeter of roll surface.
3. Sieving Surface: 44 square meters actual working surface per 16.4 tons (1,000 poods) including brush and centrifugal machines.
4. Purifier Surface: One millimeter width per 16.4 kilograms per 24 hours.
5. Roller Mill Suction: 9.72 cubic millimeters of air per minute per meter of roll surface.
6. Purifier Suction: 34.6 cubic millimeters of air per minute per purifier, 840 millimeters in width.
7. Suction to plansifters: 6.3 cubic millimeters per minute per sifter. double box type.
8. Total suction on wheat cleaning machines: 263.3 cubic meters of air per minute.
9. Total suction on milling machines: 268.9 cubic meters of air per minute, and finally,
10. Total air requirement: 9.677 cubic meters per hour per 16.4 tons (1,000 poods) mill capacity.

Positive results and conclusions obtained were as follows:

a. It was technically possible and advantageous to operate old European roll installations at higher American speeds.

b. Results of the Zaporojdye experiment on the basis of a balance sheet of milling characteristics and production quality recommended the universal application of American techniques and flow sheets.

c. The uniform fine flour produced by the modified system was of a higher extraction and of higher baking quality than flour produced by the European milling system.

Some of the specific problems requiring further investigation included:

1. To attain maximum American production standards of best quality flour it would be necessary to mill wheat cleaned by American machines and methods. Furthermore it would be advantageous to use roll corrugations with rounded edges as in the American system.

2. The Zaporojdye experiment did not succeed in attaining American requirements of sifting surface which can produce almost double the capacity with half the surface used in the European method. The reason for this required further study using sieving surfaces with the technological specifications of those used in American sifters.

On the basis of the facts established and in spite of these unsolved problems some changes were introduced in the Dniepropetrovsk mill which was then under construction. Roll speeds of 6 meters per second were introduced on break as well as reduction rolls, with the same type of roll corrugation and differential as at Mill No. 78. There was hesitation, however, to use the 7 meter speed on the roller mill built by Millstroy (agency for building machinery). Nevertheless after acquiring the techniques for dynamic balancing which had to be applied to the hollow European rolls when using American speeds, this caution proved to be superfluous. Further, on the basis of the Zaporojdye experiments, this roll speed of 6 meters per second was accepted by the Council of Science and Technology in the USSR for all new mills built after 1931. While these experiments were in progress a group of American milling specialists led by Engineer A. M.

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Marsh* was invited by the "Soyouschleb" (trust for exploitation of all mills in the USSR) in 1929 to plan and build a mill in the town of Semipalatinsk.

In 1930 experiments at Mill No. 78 were conducted and regular production was begun with a normal technical system. The peripheral roll speed of 7 meters per second on breaks and smooth rolls was used from then on. While producing three sorts of flour from uniform wheat, the quality of the flour at this Americanized mill in terms of fine granulation, ash content and extraction turned out to be higher than that from the best standard mills which continued to operate with the European system of lower peripheral speed and capacity.

Experiments in connection with the cleaning and preparation of grain for milling indicated a number of significant differences between the American and European systems.

The European method strives to remove not only the dust and other foreign material on the grain prior to milling but also the embryo and the beard. Also it attempts to remove the outer bran coat. The quality of work in the cleaning department is measured in this case by the difference in the ash content of the grain prior to cleaning and before first break. The greater this difference the more bran coats have been abraded off and the better the cleaning is considered to be. Under the microscope, grain cleaned by European techniques after it has passed through the scourers exhibits separation of hulls from almost every grain. Some hulls have been removed entirely while others remain partially adhering to the kernels. At the same time the bran coat has been scratched and torn. In some grains the embryo has been completely removed while in many others it has been partially damaged. Due to the energetic processes of grain scouring, grain damaged by uncovering of the endosperm is also evident.

The American method strives only to remove dirt, dust and foreign bodies from the surface and the crease while maintaining the bran, embryo and beard as intact as possible during the entire process of cleaning right up to the point where the actual milling begins.

Inasmuch as the European methods cause the seed coat to be considerably damaged by energetic scouring, the bran of such grain when milled breaks up on the rolls and mixes with the flour, thus lowering its quality. For this reason the Americans use milder scourers of the Forster type instead of scourers with vigorous action. These machines clean the dust and dirt from the outer surface of the kernel, lightly rubbing the outer layer of the bran. The scoured grain retains its bran coat, embryo and beard. Thus the grain surface remains strong and undamaged and withstands more easily the milling action of the rollers, with the result that much less of bran crumbles into the flour. A whiter flour results. This mechanical strength in the bran coat also makes it possible to increase the peripheral speed of the rolls, thus increasing the capacity per unit length of roll working surface.

The dampening of grain and temperature conditioning in the bin encourages a desirable fermentation process. This temperature conditioning is not accomplished as well with the European machines as with the American, due to the removal or damage of the embryo by the scourers.

With the European method of milling, in which the corrugations operate with edges sharp to sharp, at a roller speed not higher than 3½ to 4 meters per second, and with elaborate sizing and purifying of middlings, it is permissible to remove the outer bran layers of the grain in the cleaning department since the outer bran crumbles eventually and finds its way into the flour. To attain American roll speeds of 6 to 7 meters per second on breaks it is necessary to work with corrugated edges dull to dull and with rounded cutting surfaces. The outer bran cover is thus neatly peeled off, the endosperm is scooped out and a clean, fine product is extracted. This methods tends to leave the bran coat intact without the usual damage to the grain as it passes through European scourers. Thus the introduction of American methods of cleaning with the objective of retaining the seed coat intact, through the use of scourers of the Forster type, seemed fully justified.

Grain which has passed through European scourers must be treated additionally in brushing machines in order to polish it. With the American method there is no need to brush the grain as it does not suffer any tearing or damaging in scouring. Accordingly the American method of cleaning only the outer surface of the grain has a number of advantages as compared with the European method, thus justifying its adoption in the USSR. It must be noted that grain brushing machines are now practically never used in the USSR.

Average germination of grain prior to passage through European type scourers was 97%. After passing through the first scourer the ger-

*Mr. Marsh was formerly with the milling machinery department of Allis-Chalmers Mfg. Co.

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mination was reduced to 78% and after the second scourer to 57%. Experiments with mild scourers of the Forster type showed that germination was reduced by first scouring only about 2% while second scouring caused a loss in germination of an additional 1%. Thus only 2% of the grain passing to the temperature conditioning processes has no embryo and only 3% of the grain going to the break rolls is in this category.

Wheat washing machines of various firms were examined, and following trials, the American machine manufactured by Great Western Mfg. Co. was adopted to serve as a model for reproducing such machines in the USSR. Advantages of this machine as compared with the European types were found to be as follows:

1. During washing the dry grain increases in moisture by only 1½ to 2½%. Accordingly drying installations are less essential with such machines than with European washing equipment.

2. American machines use smaller volumes of water—0.252 to 1.25 liters per kilogram of washed grain or about ⅓ of that required by European machines. In addition the machine is compact, uncomplicated and convenient to use.

Balancing of Rolls

Adapting European roller mills to American speeds brought up the question of balancing them. This problem occurs because European rollers are cast hollow and the cylindrical interior is not uniform. Usually such rolls will not operate smoothly at American speeds.

When the static balance of rollers at Mill No. 90 was checked it appeared that the majority were out of balance with the differences equivalent to more than 0.5 kilograms. Most had balance differences of 3.0 kilograms and a few were unbalanced to more than 4 kilograms. Even at low speeds it is obvious that such differences must have a negative influence on production results, not to mention the undesirable dynamic aspects of the roll operation. Solid American rolls checked for balance in the course of experiments at Mill No. 78, had virtually no weight differentiation when checked for static balance.

Experimental tests for balance were conducted in a laboratory where speeds as high as 10 to 15 meters per second were applied. Taking into account the quality of machine building in the USSR prevailing at that time, it was decided to limit roll speeds under practical conditions, to 8.5 meters per second, i.e., 20% higher than the maximum American speeds. It is interesting to note that it was not possible to balance some of the Russian-made rollers even by adjustment of weight. They continued to have weight differentiations in every position tried. Finally, when they were cut open to determine the cause of different conditions, it was discovered that the inner hollow case contained pieces of casting earth weighing as much as 2½ kilograms. Investigation of this problem at the factory in Kiev which manufactured similar rollers, showed that it was difficult to completely clean out this casting earth from the inner walls of the hollow rolls. For this reason it appeared to be more expedient to cast solid rolls of the American type. Such casting produces an even distribution of mass and does away with the necessity of artificial balancing. Smooth operation at fast American speeds was thus facilitated. No opposition was encountered at the Kiev factory to the manufacture and installation of such heavier solid rolls.

It is interesting to contrast the action of American and German roll grooving on wheat kernels at the first break. The diagrams in Figures 1 and 2 illustrate the forces acting on the grain at the cutting edge of the grooves according to German and American arrangements. The resultant applied force P is taken vertically at the face of a groove. Let us divide it by F the component of force along the edge of the groove and N, perpendicular to it. Assuming that the P's for disintegrating the grain are equal on both types of the grooves the following results are achieved:

On American grooves—

$Fa = P. \cos 17° = 0.956\ P$

$Na = P. \cos 73° = 0.292\ P$

On German grooves—

$Fg = P. \cos 60° = 0.5\ P$

$Ng = P. \cos 30° = 0.866\ P$

The force component N causes crushing of the grain or of its fragments while the force factor F causes the grain to be pushed through between the rolls. Theoretically, it is quite clear that the shape of the groove and its disposition is more expedient in the American type. Practically, it is advantageous to have more F and less N since this results in the production of less break flour.

These calculations show that the American F is much greater than the German and at the same time the American N is only about ⅓ of the German. From this it is evident that the useful action with American blunt corrugations at high speed on the breaks causing unfolding of the kernel is greater than with German corrugations. In addition to this action of force F in unfolding the grain it causes scraping-off of the endosperm from the bran of the last break. The action of force N which crushes the grain is less with American corrugations

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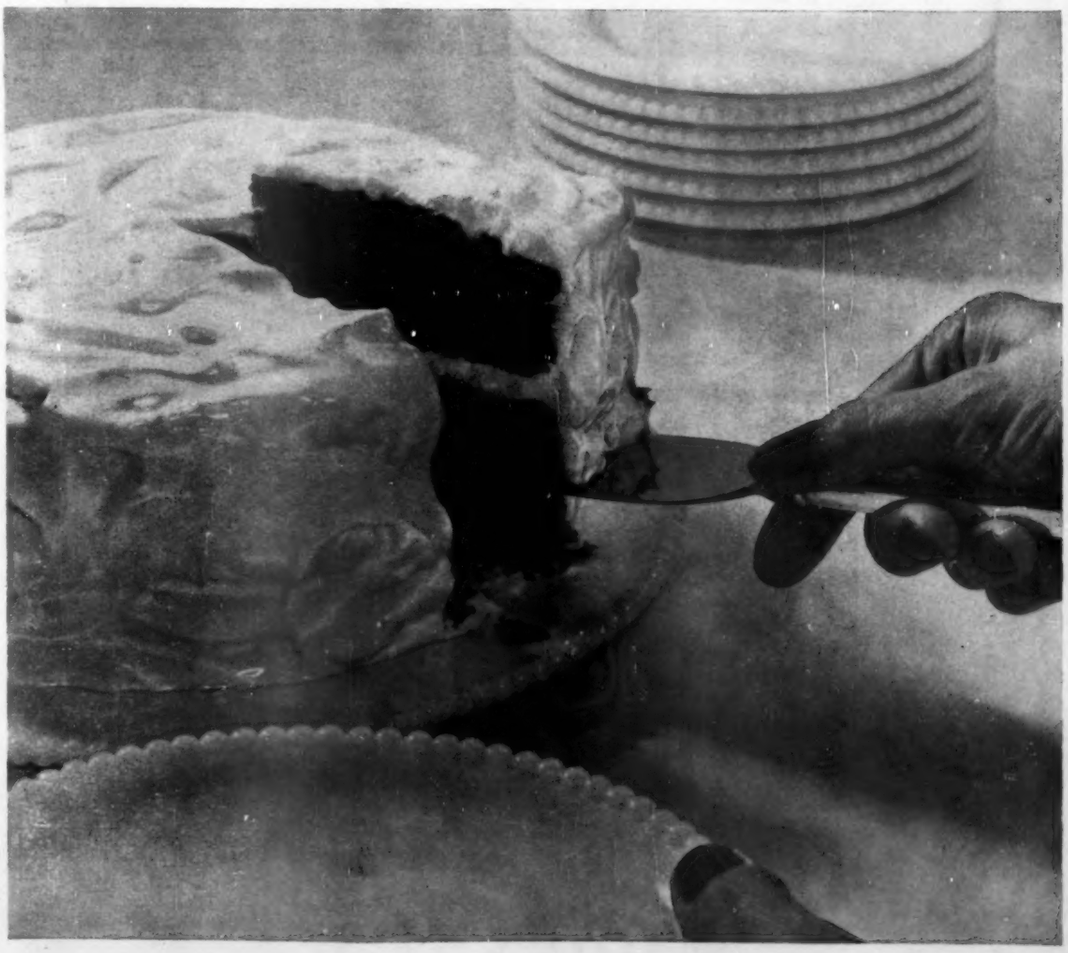

than with the German even though the speed of the rollers is doubled. This crushing action is not desirable since it usually results in the production of break flour. A comparison of quantities of break stock as well as of purified material produced in 10 experimental millings at various roll speeds and loads appears in Table 3.

In American mills middlings are divided into uniformly classified fractions and reach reduction rolls in a somewhat finer and cleaner condition than in European systems. Accordingly, it is possible by U.S. methods to grind middlings intensively on the first reduction rolls, using ground surface rollers, as is common for fine middlings and tailings. The Americans use roll differentials for middlings reduction in the range of 1:1.5 to 1:2. Since the middlings going to these reductions are low in ash content and contain little bran there is every justification to mill them into flour immediately. On European reduction stages ("milling passages"), however, high ash content of the middlings requires that they be milled lightly in order to permit removal of bran particles on the following sieves rather than pulverizing them into flour.

The intensive flour production in American systems at the first four reduction stages permits reduced loading of the rest of the reductions. This is one of the factors which justifies the use of considerably less sieving surface than in the European practice.

It was the opinion of many specialists in the USSR at that time that the American method produced smaller flour yields. This was proven to be incorrect. Actually a yield of 74.4% of flour was eventually produced which met American quality standards. In addition, with final scratch rolls, using special rollers and centrifugal machines, an additional 3.3% of flour was produced. In this fashion American milling systems in the USSR yielded 77.7% of flour yield instead of the 75% provided by mills of European type. Furthermore the flour produced by the American type mills was finer in granulation and this was of great advantage in connection with the new technical methods of bread baking which were being introduced in the USSR at that time.

A Comparison of Specifications

It is of interest to compare the technical characteristics of a mill with a capacity of 200 tons per 24 hours which was being offered at that time by American, German and English manufacturers. These data appear in Table 3.

It is evident from this table that the total working surface of rollers in the German mill is 213% greater than that in the American mill. As for the relationship between break and the reduction systems, the ratio of rotating surfaces per second in the American flow sheet is equal to 1:1.56, the speed of the break and reduction rolls being the same. In the German flow sheet the ratio of break surface per second to reduction surface per second is equal to 1.14:1, which is explained by the fact that the speed of reduction rolls is not the same as that of the break system. Also the length of the reduction system in the German flow was 1.82 times greater than in the American. With a low speed reduction system, particularly when the differential is low between fast and slow rollers, the German rolls (which have a differential of 1.25:1 as against the American differential of 1.5:1) produce a flattened product which requires detaching machines to break up after each reduction step. For this reason 25 detachers appear on the German flow sheet whereas in the American flow only three detachers are indicated and these are used only for the milling of tailings.

Comparative calculations showed that at a common capacity of 200 tons for 24 hours the American mill would cost about one half of its German counterpart.

After all the experiments and experiences described, the battle for the American system and American speeds, which went on in the USSR for a number of years, ended in victory for that system. In 1932 the "Narkomsnab" (Ministry of Food Supply) issued a directive requiring the reconstruction of all existing mills in USSR to American speeds and American milling methods, as well as the construction of all new mills by American principles. Thereafter a special office was established in Moscow to deal with the reconstruction of all existing mills to American speeds. Special courses were initiated for the engineering and other technical personnel of this office in order to acquaint them with the latest methods in American flour production.

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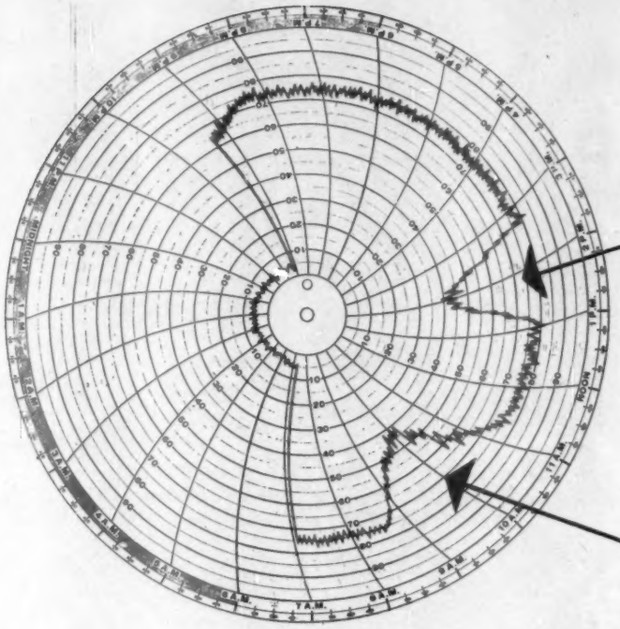

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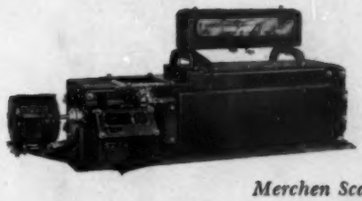

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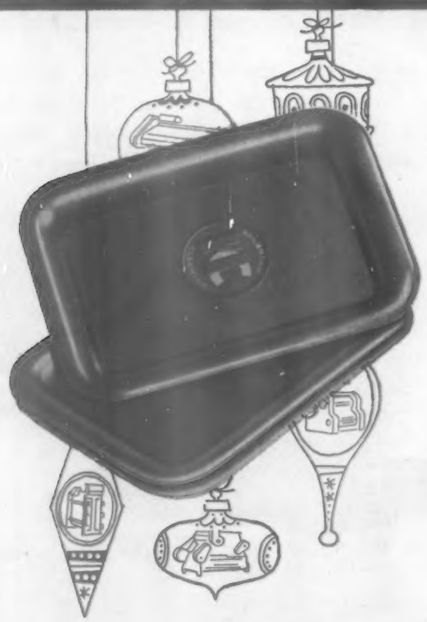

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